

## DETECTION OF BRAIN TUMOR USING ENHANCED K-STRANGE POINTS CLUSTERING AND MORPHOLOGICAL FILTERING

NORA NAIK<sup>1</sup>, ALAN PEREIRA<sup>2</sup>, SHRUTIDHEKNE<sup>3</sup>,  
SHUBHAM KADAM<sup>4</sup> & ANKITA KALANGUTKAR<sup>5</sup>

<sup>1</sup>Assistant Professor, Department of Computer Engineering, Agnel Institute of Technology & Design Goa, India

<sup>2,3,4,5</sup>BE Students, Department of Computer Engineering, Agnel Institute of Technology & Design, Goa, India

### ABSTRACT

*Image processing has become an emerging area of endless possibilities to explore and advances in this domain are gaining momentum. A brain tumor is an abnormal growth, which is caused due to cells reproducing themselves in an uncontrolled manner. In this paper, a simple and effective algorithm for detecting the presence and area of the tumor in brain MR images is described. Generally, a physician visually examines a CT or an MRI brain scan for the diagnosis of the brain tumor, which is usually a manual process. To avoid this problem, the proposed project aims to automate this problem by making use of a computer-aided method for the detection of brain tumor. This method detects brain tumor tissue with higher accuracy and lesser time as compared to the manual analysis.*

**KEYWORDS:** *Mr. Images, Segmentation, Clustering, Enhanced K-Strange Points, Morphological Filtering & Brain Tumor*

**Received:** Apr 13, 2017; **Accepted:** May 15, 2017; **Published:** Jun 08, 2017; **Paper Id.:** IJCEITRJUN20176

### INTRODUCTION

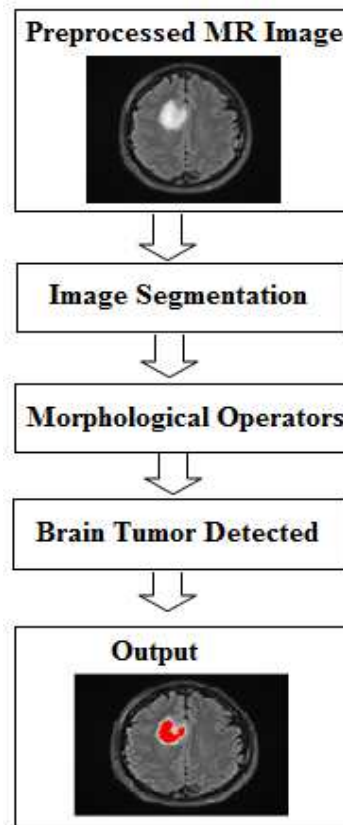
Image processing is a technique, in which we take some input image to get an improved image, or to gain some valuable information [3]. It is the organ that controls most of the activities of the human body and is the central organ of the human nervous system.

A brain tumor is defined as an abnormal growth which is caused due to the cells reproducing in an unrestrained manner inside the brain. They are further categorized as benign (non-cancerous) or malignant (cancerous). Brain tumor is a serious life altering disease and it is of great help if it is detected in the earlier stages. The traditional method followed in hospitals for diagnosis is that the physician segments the MRI or the CT scan manually to detect a brain tumor region. This method mostly depends on the skills and the experience of the physician. Also, the shortage of radiologist and ever increasing number of cases make this process both time consuming and expensive.

In our proposed methodology, we make use of a computer-aided method, which makes use of Enhanced K-Strange Points clustering algorithm followed by Morphological Filtering for detecting and isolating the tumorous region in the brain MR images, which is the Region of Interest (ROI)[6] for the entire image followed by calculating the area of the ROI.

## PROPOSED SYSTEM

The input to the proposed system is preprocessed MR images, which are stored in a specific folder on the system (computer) and its output is the tumor region detected. The proposed system consists of the following steps as shown in the flowchart below:



**Figure 1: Proposed System Flowchart**

### Image Acquisition (Input Image)

MR images of the brain are acquired from hospitals, radiologists and internet.

### Preprocessed Image

Pre-processing mainly involves those operations that are normally necessary prior to the main goal analysis and extraction of the desired information. These improvements include correcting the data for irregularities and unwanted noise, removal of non-brain element image, etc. In the proposed system, we make use of preprocessed grayscale MR images without presence of any noise, labels etc.

### Image Segmentation

Image segmentation is the process of partitioning a digital image into multiple segments that share similar attributes (like color) to simplify the representation and making it more useful for the analysis and interpretation.

Clustering is a simple technique by which we can group objects together such that the objects which are present in the same group or cluster have more similarity with each other than the objects which are present in a different group.

### Enhanced K-Strange Points Clustering Algorithm

The Enhanced K-Strange Points Clustering algorithm is clustering method, which produces high quality clusters with high intra clusters and low inter cluster similarity i.e. the objects within the same cluster have a high similarity to each other and high dissimilarity to objects in other clusters. Initially, the Euclidean distance is measured between all the points in the dataset. Using this distance, the Enhanced K-Strange Points Clustering algorithm selects 2 points from the dataset, which are at maximum distance from each other. It then selects a third point, which is farthest away from the previously selected 2 points such that the sum of these 3 points is larger than any other combination. This process is repeated to get the required number of clusters K.

Enhanced K-Strange Points algorithm is given as below.

Input to the algorithm:

K- Number of required clusters

D-Dataset

Output of the algorithm:

K clusters set.

Begin

- Search the minimum point of dataset,  $K_{m1}$
- Search  $K_{m2}$  the point which is at maximum distance from  $K_{m1}$ ,
- Consider a third point P, which is farthest from  $K_{m1}$  and  $K_{m2}$
- if( $\text{dist}(K_{m1}, P) == \text{dist}(K_{m2}, P)$ )

$K_s = P$

If ( $\text{dist}(K_{m1}, P) < \text{dist}(K_{m2}, P)$ )

$$K_s = K_{s(\text{previous})} + X_r \left( \frac{K_{m2} - K_{s(\text{previous})}}{K-1} \right)$$

If ( $\text{dist}(K_{m1}, P) > \text{dist}(K_{m2}, P)$ )

$$K_s = K_{m1} + X_r \left( \frac{K_{s(\text{previous})} - K_{m1}}{K-1} \right)$$

K = number of total clusters required by user.

$X_r = \text{range}(r = 1, 2, 3, 4, 5, \dots, K-2)$

$X_1 = 1$ , for initial revised value of P

$X_1 = 2$ , for next revised value of P

$K_{s(\text{previous})} = \text{unrevised value of P}$

$K_s = \text{revised value of P}$

- Locate the required number of K strange points by repeating the above procedure and using the found K strange points from the clusters by assigning the values in the dataset to them.
- Return K clusters.

### **Morphological Operators**

Morphology is the study of shapes. Mathematical morphology is a tool for extracting geometric information from binary and gray-scale images. Morphological operations are used to identify the shape, structure, edges, holes etc. in the images. Dilation and Erosion are two important morphological operations that are used for eliminating the irrelevant cells and for filling the gaps from the brain image.

### **Erosion & Dilation**

The two main operations used in morphology are known as 1) Erosion 2) Dilation. Erosion is applied to decrease the size of the object whereas dilation is applied to increase the size of the object. Using dilation, the relevant and broken segments are easily joined. Using erosion, the interested portion of the image is displayed by using the structuring elements. With this, the unwanted portion is removed and only the tumor affected ROI is displayed.

Erosion & dilation are the morphological operations, which describe the interaction of the image with a structuring element S. A structuring element is nothing but a small set used to probe the image. An origin must also be defined for each structuring element so as to allow its positioning at a given point or pixel. A structuring element at point X means that its origin coincides with X. In practice, the shape and size of the structuring element must be adapted to the image patterns that are to be processed. The structuring element used by the proposed system is a disk-shaped structuring element since brain tumors normally occur in the shape of a disk.

### **Closing**

Closing is an important operator from the field of mathematical morphology. It is defined as a process, in which we perform dilation followed by erosion. The effect of the operator is to preserve the background that have a similar shape to the structuring element, while eliminating all other regions of background pixels.

### **Tumor Area Calculation**

The area of the tumor region is computed by performing the following steps.

Algorithm:

#### **Input:**

- Image after performing closing operation taken as img1.
- Image after performing erosion operation taken as img2.

**Output:** Tumor region in image img3.

1. Scan img2 for the first white pixel.
2. Perform region growing from that pixel with reference to img1 and save the region in another image, say img3.
3. Subtract img3 from img2

4. If there is another white pixel found while scanning img2, then perform erosion on img2 and go to step 1.
5. Perform region growing on image img1 with respect to output of closing operation.
6. Stop.

After performing the above operations calculate the area using the following equation. [9]

$$\text{Area of tumor, } A = [(\sqrt{P_i}) * 0.264] \text{ mm}^2$$

Where,

A= Area of the tumor.

P<sub>i</sub>=Number of white pixels.

1 Pixel = 0.264 mm.

## EXPERIMENTAL RESULTS OF PROPOSED METHODOLOGY

The proposed system was tested on a dataset of 40 preprocessed MR images of size 300\*300 in non-medical format (.jpeg, .png etc.). The results obtained from Enhanced K-Strange Points clustering algorithm were then compared with K-Means clustering algorithm.

It was seen that out of the 40 preprocessed MR images tested K-Means failed to provide an accurate result for 5 images, while the Enhanced K-Strange Points clustering algorithm gave an accurate result for all the images in the entire dataset. The clustering algorithms, Enhanced K-Strange Points and K-Means algorithm were applied on the preprocessed images

It was observed that K-Means algorithm converged after more number of steps, when K was chosen as 2 as compared to the Enhanced K-Strange Points Clustering algorithm. The performance of the K-Means algorithm gradually deteriorated with the increase in the number of samples (pixel values).

The segmentation results using the Enhanced K-Strange Points Clustering algorithm were found to be more accurate and acceptable as compared to those obtained from the K-Means Clustering algorithm.

Enhanced K-Strange Points Clustering algorithm converged faster than the K-Means algorithm when applied on the same dataset. The Enhanced K-Strange Points clustering algorithm has a time complexity of  $O(4n+(k-2)d)$  and the K-Means clustering algorithm has a time complexity of  $O(nktd)$ . Efficiency of the Enhanced K-Strange Points Clustering algorithm was found to be better than that of K-Means Clustering algorithm.

**Table 1**

Specification	Operating System	Enhanced K-Strange 2 Clusters (Sec)	Enhanced K-Strange 4 Clusters (Sec)	K-means 2 Clusters(Sec)	K-Means 4 Clusters(Sec)
Intel(R) Core (TM) i5-4210U CPU @ 1.70 GHz 2.40 GHz RAM:- 8.00 GB	Windows64-bit Operating System, x64-based processor.	0.09	0.122	0.098	0.185
Intel(R) Core (TM) i3-4130U CPU @ 3.40	Windows64-bit Operating System, x64-	0.08	0.156	0.086	0.096

GHz 3.40 GHz RAM:- 4.00 GB	based processor.				
2.7 GHZ Dual Core Intel Core i5RAM: 8 GB	Mac OS (10.12) Sierra	0.04	0.067	0.085	0.148
Intel(R) Core (TM) i3-4130U CPU @ 3.40 GHz 3.40 GHz RAM:- 4.00 GB	Ubuntu 14.04	0.057	0.058	0.089	0.099

As we can see in the above table, the result for Enhanced K-strange points clustering algorithm was faster than K-means algorithm for 2 clusters, as well as 4 clusters.

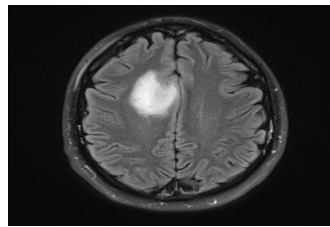


Figure 2: Original MR Image

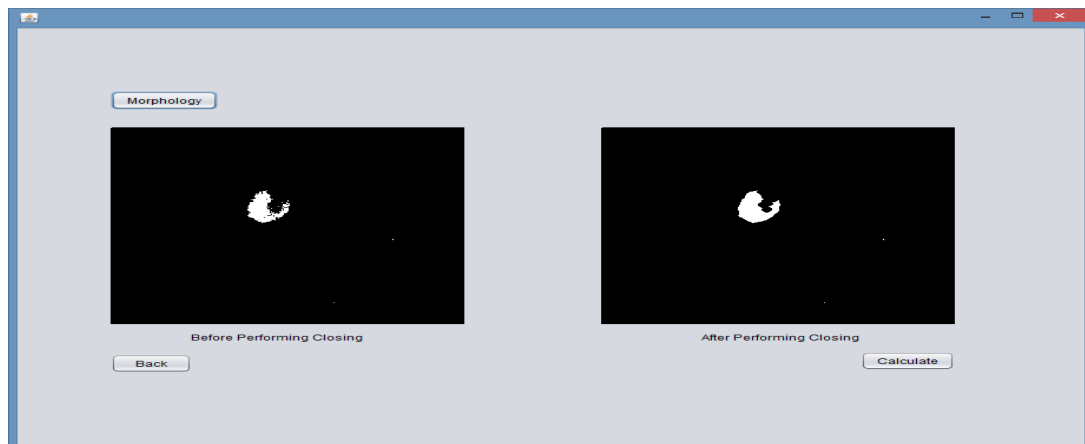


Figure 3: Showing Result Before and After Performing Closing Operation

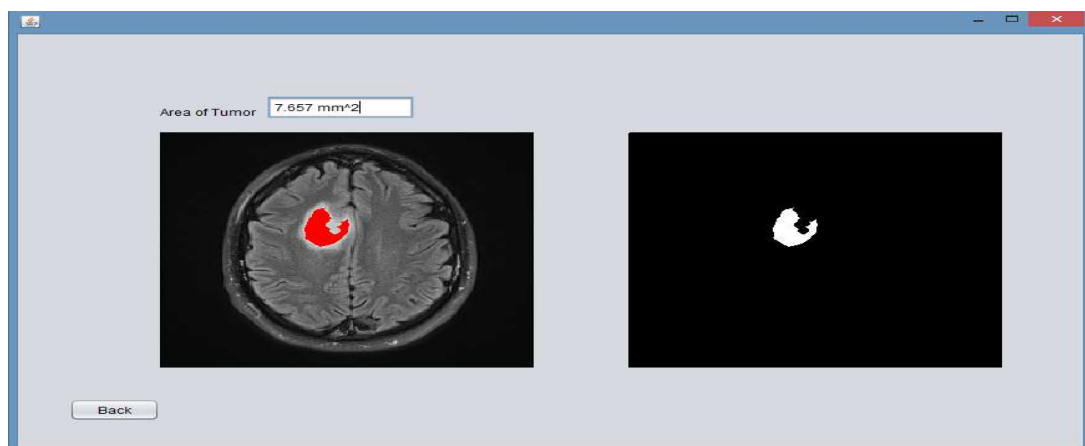
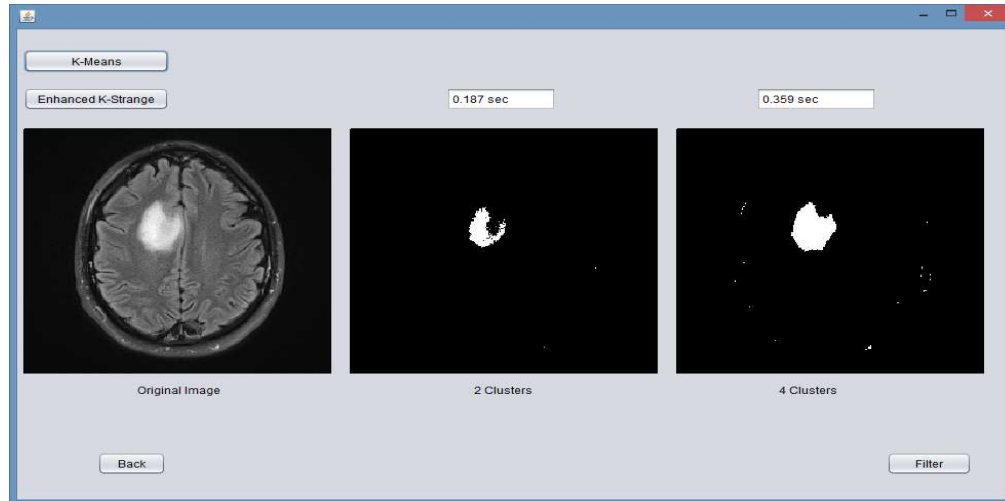


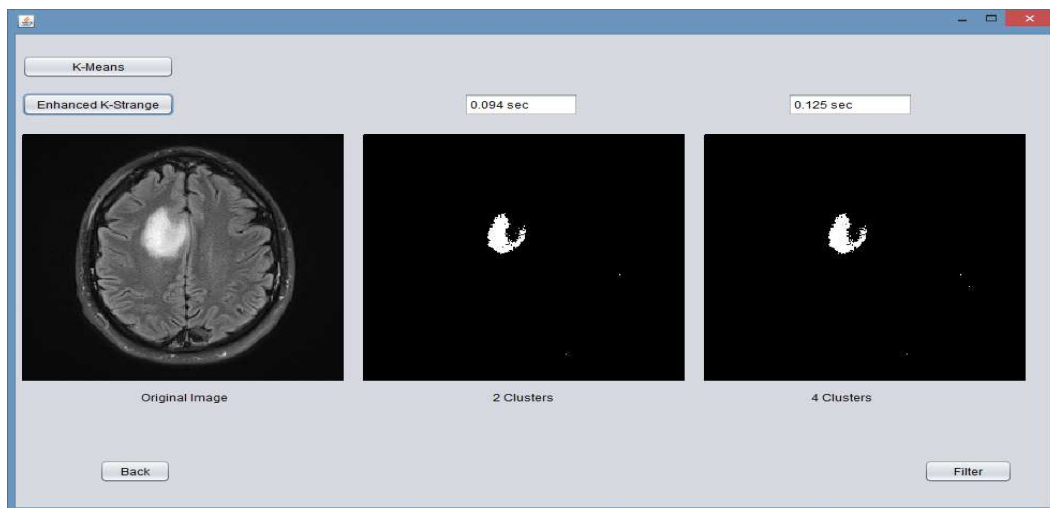
Figure 4: Tumor Detected and Area of Tumor Region Calculated

As we can see from the Figure 2, it shows the original preprocessed MR image, Figure 3 shows the resultant image, after performing the closing operation, and Figure 4 shows the detected tumorous region.

### Comparison with Enhanced K-Strange Points Clustering and K-Means Clustering



**Figure 5: Result of K-Means Clustering Algorithm**



**Figure 6: Result of Enhanced K-Strange Points Clustering Algorithm**

According to Figure 5 and Figure 6, we see that even to the naked eye, the results obtained by using 2 clusters were seen to be identical in case of both K-means clustering algorithm as well as Enhanced K-strange Points clustering algorithm. Hence, it is ideal to use 2 clusters instead of 4 clusters. It is also observed from Figure 5 and Figure 6 that, the Enhanced K-Strange Points clustering algorithm was faster as well as more accurate, when compared with the K-means clustering algorithm.

K-means algorithm led to the fusion of pixels in close proximity with the brightest pixels. Similarly, we can see another example of Enhanced K-strange points clustering algorithm providing a faster as well as a more accurate result in the figures 7-10 shown below.

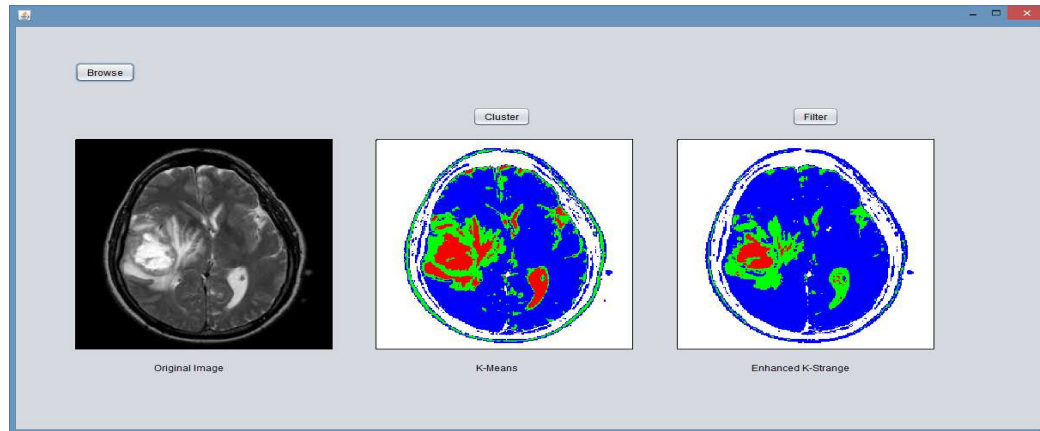


Figure 7: Initial MR Image Input

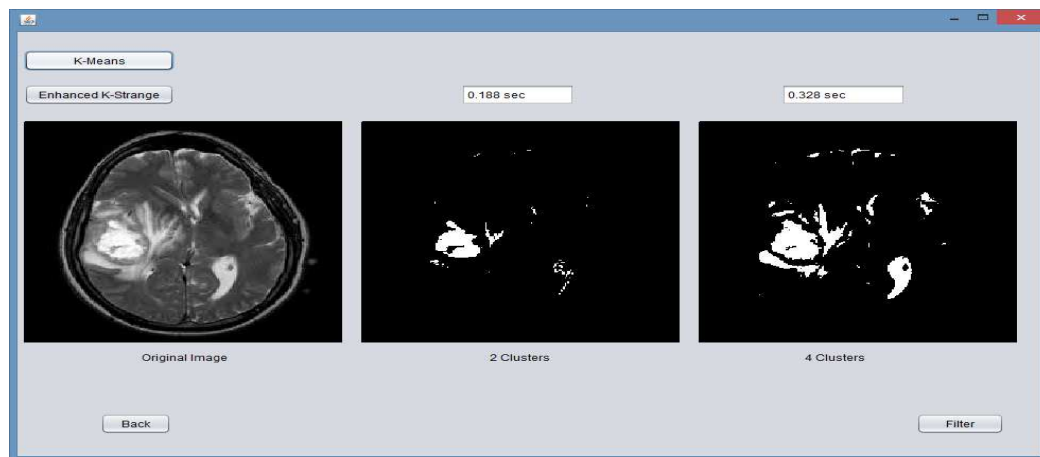


Figure 8: Result after Performing K-Means Clustering Algorithm

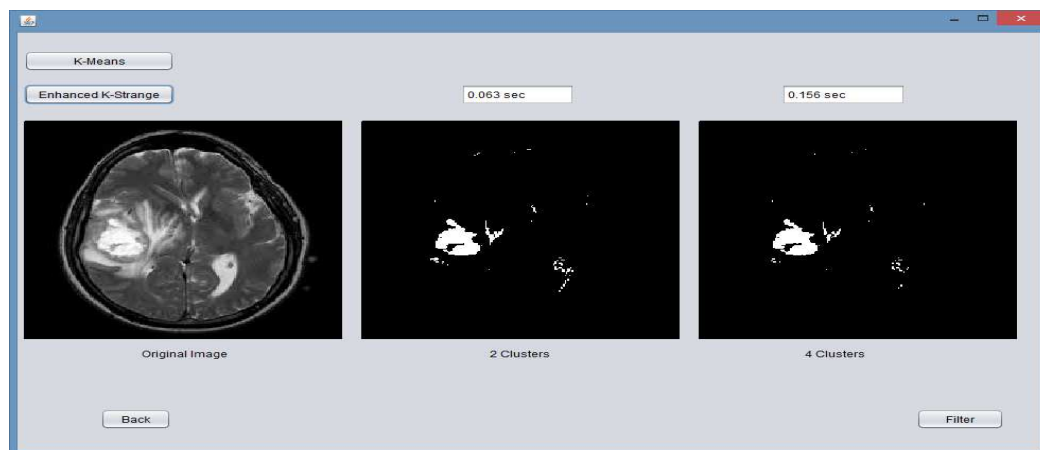


Figure 9: Result of Performing Enhanced K-Strange Points Clustering Algorithm





**Figure 10: Tumor Region Detected**

## CONCLUSIONS

Early detection of brain tumor has got a very important role in the treatment and its cure. Brain tumor detection is a tedious job because of the complex structure of the brain. From the MR images, the information such as tumor location can be understood, but doctors do not have a method that can be used for brain tumor detection and standardization, which leads to varying conclusions between one doctor to another. There comes the requirement of an automated system for locating tumor in Magnetic Resonance Image (MRI).

The existing classification methods have limitation in accuracy, exactness and require manual interaction. So, designing automated system using image segmentation techniques helps make the detection accurate and efficient. In our work, we have proposed a computer-aided solution for brain MR image segmentation using Enhanced K-Strange Points Clustering algorithm, followed by Morphological Filtering. The proposed system can be used as a second decision making tool for surgeons and radiologists. The Enhanced K-Strange Points Clustering algorithm converged faster with less number of steps than the K-Means Clustering algorithm. We were able to segment the tumorous region accurately and efficiently from the different brain MR images present in our dataset.

## REFERENCES

- 1 Rohini Paul Joseph, C.Senthil Singh, M.Manikandan, "Brain" Tumor MRI Image Segmentation and Detection in Image Processing", *International Journal of Research in Engineering and Technology*, e ISSN: 2319-1163/ p ISSN: 2321-7308
- 2 Terence Johnson, Dr.Santosh Kumar Singh, "Enhanced K Strange Points Clustering Algorithm", 2015 International Conference on Engineering Information Technology and Engineering Solutions, ©2015 IEEE DOI 10.1109/EITES.2015.14
- 3 Malathi R, Dr. Nadirabanu Kamal A R, "Brain Tumor Detection and Identification Using K-Means Clustering Technique", *Proceedings of UGC Sponsored National Conference on Advanced Networking and Applications*, 27 March 2015
- 4 S.Roy, et al., "A Review on Automated Brain Tumor Detection and Segmentation from MRI of Brain", 1312.6150, 2013.
- 5 M.C.Jobin Christ, R.M.S.Parvathi, "Segmentation of Medical Image using Clustering and Watershed Algorithms", in *American Journal of Applied Sciences*, vol. 8, pp. 1349-1352, 2011.
- 6 Kshitij Bhagwat, Dhanshri More, SayaliShinde, AkshayDaga, RupaliTornekar, "Comparative Study of Brain Tumor Detection

*Using K-Means, Fuzzy C Means and Hierarchical Clustering Algorithms”, International Journal of Scientific and Engineering Research, Volume 4, Issue 6, June-2013 ISSN 2229-5518*

- 7 Mohammed Y. Kamil, “Brain Tumor AreaCalculation in CT-scan image using morphologicalOperations”, *IOSR Journal of Computer Engineering (IOSR-JCE) ISSN: 2278-8727, Volume 17, Issue 2, Ver.-V, PP 125-128, Mar – Apr. 2015.*
- 8 Amer Al-Badarnech, Hassan Najadat, Ali M.Alraziqi, “A Classifier to Detect Tumor Disease inMRI Brain Images”, *IEEE Computer Society, ASONAM. 2012,142*
- 9 Abhilasha Mishra, M.R.Rathod, Sanghamitra T. Kamble, “Brain Tumor Area Calculation Using K-Means And Fuzzy C Mean Clustering Algorithm”, *Proceedings of 28th IRF International Conference, 7th June 2015, Pune, India, ISBN: 978-93-85465-29-1*